MAMMALIAN SPECIES No. 383, pp. 1–4, 3 figs.

Geomys breviceps.

By James M. Sulentich, Lawrence R. Williams, and Guy N. Cameron.

Published 6 November 1991 by The American Society of Mammalogists

Geomys breviceps Baird, 1855

Baird's Pocket Gopher

Geomys breviceps Baird, 1855:335. Type locality "Mer Rouge, Morehouse Parish, Louisiana."

Geomys bursarius breviceps: Baker and Glass, 1951:57, name combination.

CONTEXT AND CONTENT. Order Rodentia, Family Geomyidae, Subfamily Geomyinae. Two subspecies are recognized (Bohlin and Zimmerman, 1982):

G. b. breviceps Baird, 1855:335, see above.

G. b. sagittalis Merriam, 1895:134. Type locality "Clear Creek, Galveston Bay, Harris Co., Texas" (*brazensis* Davis, *dutcheri* Davis, *ludemani* Davis, and *pratincola* Davis are synonyms).

DIAGNOSIS. Three species of *Geomys* currently are recognized in eastern Texas. *G. attwateri*, *G. breviceps*, and *G. bursarius* are cryptic species and cannot be distinguished on the basis of external morphological characteristics. Compared with *G. bursarius*, the dorsal exposure of the jugal bone on the dorsal surface of the zygomatic arch is shorter than the width of the rostrum in *G. attwateri* and *G. breviceps* (Schmidly, 1983). All three species are distinguished by cytological and biochemical characteristics. Chromosomal races comprising the *G. bursarius* group have a 2n ranging from 69 to 72, a FN from 68 to 72, and an acrocentric X chromosome. Races in the *G. breviceps* group have a 2n of 74, FN of 72 or 74, and the X chromosome is submetacentric. Races in the *G. attwateri* group have a 2n of 70, FN of 72 or 74, and the X chromosome is submetacentric (Honeycutt and Schmidly, 1979). *G. breviceps* is characterized by centromeric or pericentromeric C-bands, whereas *G. attwateri* contains large heterochromatic regions in the karyotypes. In addition, G-band analysis reveals that *G. breviceps* differs from *G. attwateri* by at least two centric fission-fussion events (Dowler, 1989).

GENERAL CHARACTERS. Like other pocket gophers, *G. breviceps* is characterized by a cylindrical body that is heaviest anteriorly, especially around the shoulders (Fig. 1). The neck is reduced, and the thickest portion of the body is at the back part of the head from which the body tapers gradually to the tail. The body is covered by short, fine hair; pelage is pale brown to black, usually paler ventrally. Large, fur-lined external cheek pouches are used for transporting food. Eyes are small and ears are reduced. Tail is shortened, thickened, and naked, except for a few hairs at the base. The front feet have long, curved claws used for digging, whereas claws on the hind feet are smaller. Permanent dentition consists of i 1/1, c 0/0, p 1/1, m 3/3, total 20 (Fig. 2; Schmidly, 1983).

Means and ranges of external measurements (in mm) for 74 individuals from east Texas are (Honeycutt and Schmidly, 1979; Schmidly, 1983): total length, 208 (192–222); length of tail, 61.4 (54–67); length of hind foot, 25.6 (23–28). Means and ranges of skull dimensions (in mm) for these individuals are: greatest length of skull, 38.2 (34.0–41.7); length of rostrum, 15.7 (13.7–17.7); palatal length, 21.8 (19.3–24.0); mastoidal breadth, 21.4 (18.9–23.9); palatofrontal depth 13.6 (12.4–15.0). Means and ranges of cranial measurements (in mm) for 20 males and 19 females (in parentheses) from central Texas are (Tucker and Schmidly, 1981): greatest length of skull, 42.7, 37.4–46.6 (39.1, 36.8–43.0); basal length, 40.4, 35.3–44.2 (36.9, 34.7–40.6); breadth of rostrum, 9.7, 8.9–10.6 (8.8, 8.2–9.4); mastoidal breadth, 23.9, 20.5–26.1 (21.9, 20.2–24.6); length of nasals, 14.6, 11.6–17.4 (12.7, 11.7–14.1); length of rostrum, 18.2, 14.6–20.3 (16.3, 15.1–18.5); zygomatic breath, 27.2, 22.9–30.3 (24.0, 22.5–26.5); interorbital breadth, 6.6, 6.1–7.6 (6.4, 5.9–7.1); breadth of braincase, 18.5, 16.9–20.8 (17.5, 16.1–19.6); length of maxillary toothrow, 8.8, 8.0–9.9 (8.4, 7.9–9.2); palatal length, 27.3, 23.1–30.0 (24.5, 22.9–27.9); palatofrontal depth, 16.9, 14.8–18.4 (15.7, 14.9–16.7).

DISTRIBUTION. *Geomys breviceps* ranges from the eastern bank of the Brazos River in central and southeastern Texas eastward into western Louisiana then north into southwestern Arkansas and eastern Oklahoma, just east of Norman (Honeycutt and Schmidly, 1979; Fig. 3). The Brazos River significantly affects the distribution of *G. breviceps* and maintains this species' allopatric distribution with *G. attwateri* located on the western side of the river. The Navasota and San Jacinto rivers, located east of the Brazos River, are not as effective in limiting distribution because *G. breviceps* occurs on both sides of these rivers. *G. b. breviceps* is found only in the vicinity of Mer Rouge, Morehouse Parish, Louisiana (Fig. 3).

There are contact zones of *G. breviceps* with *G. attwateri* in central Texas, 24 km northwest of College Station, Brazos County (Tucker and Schmidly, 1981), and with *G. bursarius* near Norman, Cleveland County, Oklahoma, and in Falls and McClennan counties in central Texas where they are separated by a distance of 14 km (Bohlin and Zimmerman, 1982; Zimmerman and Gayden, 1981).

FOSSIL RECORD. Fossil history of *Geomys* is discussed in Williams and Cameron (1991). *G. breviceps* is not known from the fossil record.

FORM AND FUNCTION. The baculum of *G. breviceps sagittalis* is similar in size (length, 9.56 mm; width of base, 1.69 mm) to *G. attwateri* (length, 9.86 mm; width of base, 1.70 mm). However, the baculum of *G. breviceps* is smaller than that of *G. bursarius* (length, 11.32 mm; width of base, 1.82 mm) or *G. lutescens* (length, 10.78 mm; width of base, 1.98 mm; Heaney and Timm, 1983; Kennerly, 1958).

ONTOGENY AND REPRODUCTION. *Geomys breviceps* is reproductively active during a continuous 7-month period from February through August as indicated by the collection of pregnant and postpartum females. Peak reproductive activity occurs in June and July with an additional peak of lesser intensity in April (Wood, 1949).

Anatomical and physiological changes in adult females associated with reproduction include enlargement of the uterus and the appearance of definite follicles within the ovaries. Definite follicles within the ovaries appear in January and March with a minor peak in September. Increase in definite follicles preceeds peak reproduction by 1 month (Wood, 1949).

Although the condition and position of testes in males commonly is used to indicate breeding in mammals, there is no correlation between testes position in *G. breviceps* and the reproductive pattern in females or sperm production. Rather, testis size is a more reliable indicator of reproductive activity in males. Testes >11 mm long

FIG. 1. Baird's pocket gopher, *Geomys breviceps*, from Harris County, Texas.

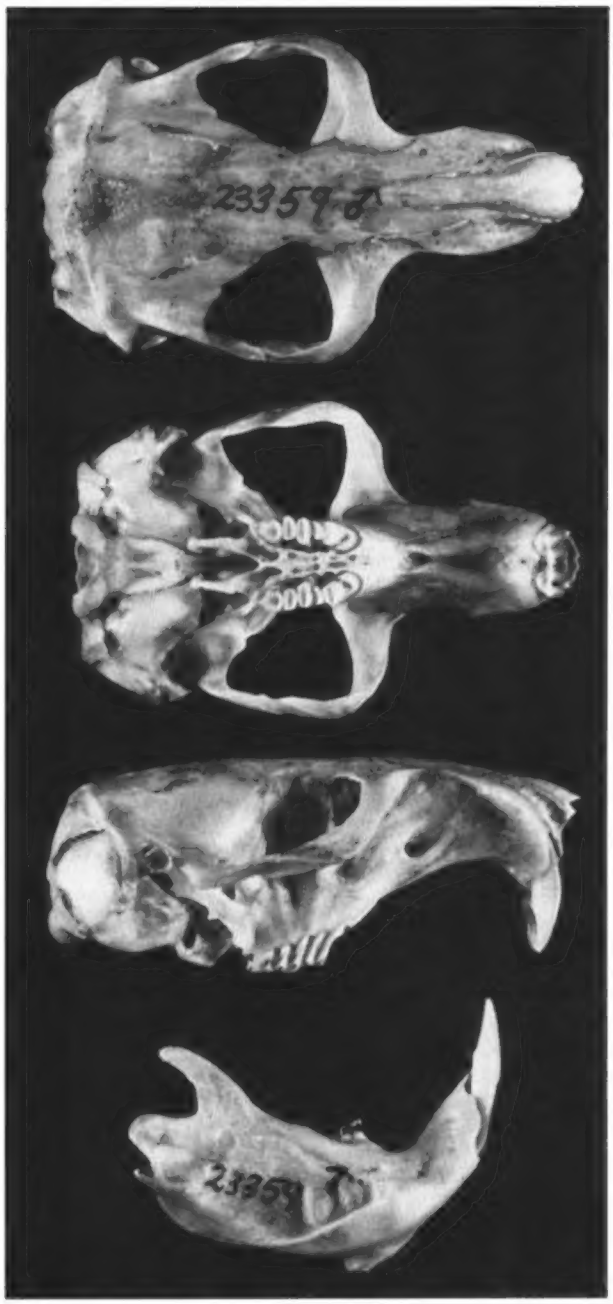

FIG. 2. Dorsal, ventral, and lateral views of skull and lateral view of lower jaw of *Geomys breviceps* from Brazos County, Texas (male, Texas Cooperative Wildlife Collection, Texas A&M University, 23359). Greatest length of skull is 43.1 mm.

have large epididymides and contain sperm; testes <11 mm do not. The average length of testes from July through October is <11 mm, but is >11 mm in other months (Wood, 1949).

The percentage of virgin or immature females within populations of *G. breviceps* is greatest during September and October (42.3 and 25.8%, respectively), and least during November and December–January (3.3 and 0%, respectively). Percentage of virgins increases to 20.6% in May (Wood, 1949).

Based on the number of pregnant females of *G. breviceps* collected during the breeding season, the average number of litters/year was 1.31. This estimate may be unreliable, because pregnant females seem more wary or less active than non-pregnant individuals. A more accurate estimate of 1.70 liters/year was based on examination of postpartum females. *G. breviceps* may produce two litters/year in rapid succession, based on five females possessing both placental scars and embryos (Wood, 1949).

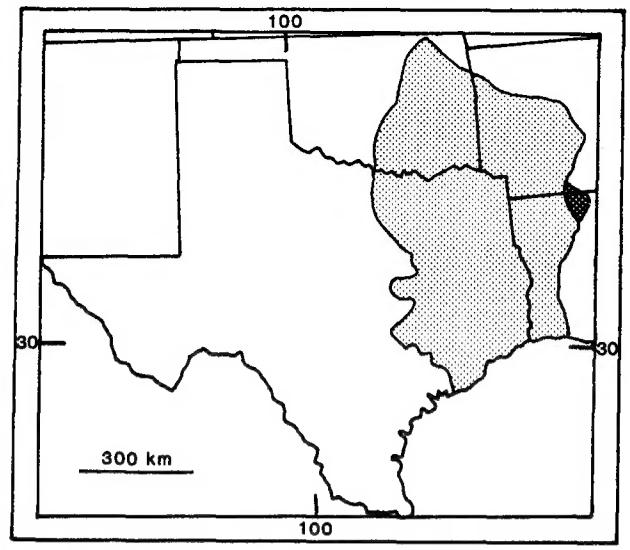

FIG. 3. Distribution of *Geomys breviceps breviceps* (cross hatched area) and *G. b. sagittalis* (stippled area) in the southcentral United States (after Honeycutt and Schmidly, 1979).

The number of young/litter determined from counts in nests of *G. breviceps* averaged 2.66 and ranged from one to four individuals. Average litter size, determined from counting embryos and placental scars, was 2.60 (Wood, 1949) and 2.36 (English, 1932). Sex ratio for *G. breviceps*, based on embryos and nestlings, was 44.8% males and 55.2% females. Sex ratio for subadults was 40.4% males to 59.6% females (Wood, 1949).

Absorption of the pubic symphyses in females occurs at puberty, not at the onset of breeding, because of hormonal activity by the ovaries. Females weighing <90 g have closed pubic symphyses and are considered juveniles, whereas females weighing >90 g have open symphyses. The latter condition indicated sexual maturity, attained about 90 days after birth (Wood, 1949).

ECOLOGY. Most of the information on the ecology of *G. breviceps* has been gathered in the vicinity of College Station, Brazos County, Texas, an area on the Gulf Coastal Plain with a mosaic of three soil types. Baird's pocket gophers commonly occur in the fine sandy loams of the Lufkin and Ochlockonee soil types where topsoil depth is >10 cm. Because the third soil type, Wilson sandy loam, becomes hard and compact when dry, *G. breviceps* is absent from it. This species is less common in soils with high moisture content (Davis et al., 1938). Tucker and Schmidly (1981) report no differences in soil selection between *G. breviceps* and *G. attwateri* in Burleson County, Texas, where soils are in the Ships-Norwood-Yahola association. These soils consist of clay, silt loam to silty clay, and silt loam to fine loam. However, Honeycutt and Schmidly (1979) found more use of clay loam soil by *G. breviceps* than *G. attwateri* in this area.

Burrows average 6 cm in diameter and are found at depths ranging from 10 to 68 cm (Davis et al., 1938). Burrows rarely extend into clay subsoils. Burrow systems are complex and may be from 55 to 180 m in length (Schmidly, 1983).

Geomys breviceps constructs large nesting mounds that may measure 1.8 m in diameter and rise 30–61 cm above ground level. Nest location within the mound may change seasonally. Nests commonly are found high in mounds during wetter months, but during drier seasons they may be located 30 cm below ground. Therefore, nest mounds may provide individuals with nesting or living quarters well above temporary flood levels (English, 1932). Examination of six nests with litters revealed a globular shape with one exit, construction of dry Bermuda grass (*Cynodon dactylon*), and average mass of 61.5 g (Wood, 1955).

The diet is composed of a variety of roots, stems, and leaves representative of the plants within the vicinity of the nest. Food is obtained during the excavation of lateral tunnels, which may radiate from the mound, and is transported in the fur-lined cheek pouches to the mound where it is generally stored. Food stores recovered from caches within disturbed prairie and fallow farmland or fields

consisted of at least 15 plant species including Bermuda grass (*C. dactylon*), nut-grass bulbs (*Cyperus esculentus*), crow-poison bulbs (*Nothoscordium bivalve*), bur clover (*Medicago denticulata*), Johnsongrass (*Sorghum halepense*), mullein (*Verbascum thapsus*), plantain (*Plantago occidentalis*), and bull nettle roots (*Cnidoscolus texanus*; English, 1932).

Cellulose-digesting bacteria occur in the caecum and large intestine of *G. breviceps*. These symbionts may be most important during the winter months when the proportion of cellulose in the diet is greatest. *G. breviceps* also reingest fecal pellets (Boley and Kennerly, 1969).

Population density in prairie habitat on soil types such as Lufkin and Ochlocknoee fine-sandy loams in the vicinity of College Station, Texas, was estimated to be 0.55 gophers/ha (Davis et al., 1938). These animals transport soil to the surface at a rate of 132.5 kg ha^{-1} $year^{-1}$ in tall-grass prairie habitat and 2,606 kg ha^{-1} $year^{-1}$ in grassland containing oaks (*Quercus stellata*) and yaupon (*Ilex vomitoria*). Loss of vegetation as a result of mound building has been estimated to be 0.2%/ha in the tall-grass prairie and 3.44%/ha in the grassland (Buechner, 1942).

King snakes (*Lampropeltis getulus*), great-horned owls (*Bubo virginianus*), red-tailed hawks (*Buteo jamaicensis*), long-tailed weasels (*Mustela frenata*), and striped skunks (*Mephitis mephitis*) are predators of *G. breviceps*. From 161 *G. breviceps*, lice (*Trichodeates geomydis*) were collected from 119 individuals mites (*Laelaps*) were on 11, roundworms (*Protospirura ascaroidea*) were in 23, and flatworms (*Hymenolepsis*) were in 8 (English, 1932). Chewing lice, *Geomydoecus ewingi*, also occur on *G. breviceps* (Timm and Price, 1980).

The distributional boundary between *G. breviceps* and *G. attwateri* roughly corresponds to the boundary between two species of lice, *Geomydoecus subgeomydis* and *G. ewingi*. *G. ewingi* generally is found on *G. breviceps*, and *G. subgeomydis* usually is on *G. attwateri*. However, *G. breviceps* along the Brazos River is parasitized by *G. subgeomydis* and *G. ewingi* is found to the west in Atascosa, Bexar, Goliad, and Wilson counties separated from the main body of *G. ewingi* to the east by a population of *G. subgeomydis* (Timm and Price, 1980).

BEHAVIOR. *Geomys breviceps* is a fossorial species that primarily is nocturnal and solitary in habit, spending virtually its entire existence within the tunnel system (English, 1932). This species uses one or more lateral tunnels leading from the living quarters as defecatoria and seals tunnels no longer used for this purpose (Wood, 1955).

GENETICS. The earliest reported karyotype for *G. breviceps* identified a diploid number (2n) of 84 chromosomes (Cross, 1931). However, subsequent analyses found the correct 2n was 74 (Bohlin and Zimmerman, 1982; Hart, 1978; Honeycutt and Schmidly, 1979; Kim, 1972). Two chromosomal races have been described for *G. breviceps*, race E possessing a fundamental number (FN) of 72 and race H, known from only two localities at the western edge of the range in Texas, with a FN of 74 (Kim, 1972). However, a subsequent karotypic study of *G. breviceps*, including examination of specimens from localities described by Kim (1972), produced no individuals of race H (Honeycutt and Schmidly, 1979). Sex chromosomes are morphologically similar for the races with a medium-sized submetacentric X chromosome and a small acrocentric Y chromosome. Dowler (1989) reported that constitutive heterochromatin (C-bands) was restricted to the centromeres and pericentromeric regions of most chromosomes including the X chromosome in a female from race E. The Y chromosome, one medium-sized pair, and the three smallest autosomal pairs appear almost entirely heterochromatic. Compared with other mammals, chromosomes of *G. breviceps* contain large amounts of heterochromatin; large blocks of heterochromatin are situated between centromeric regions and euchromatic arms and three pairs of autosomes are totally heterochromatic (Qumsiyeh et al., 1988). Based on measurements of C-banding, the estimated percentage of heterochromatin in the karyotype of race E was 42.8% (Dowler, 1989). Mean nuclear DNA content does not differ significantly between *G. breviceps* and *G. attwateri*, but distribution of heterochromatin and amount of chromomycin-bright heterochromatin are different (Burton and Bickham, 1989).

Karyotypic hybrids have been found between *G. breviceps* and other closely related species. Karyotypic hybrids are known between race E (*G. breviceps*) and race G (*G. attwateri*) in Burleson County, Texas (Dowler, 1989; Honeycutt and Schmidly, 1979). One F1 hybrid was identified between race E and race D of *G. bursarius* from a contact zone near Norman, Cleveland County, Oklahoma (Hart, 1978).

Genic differences over the range of race E of *G. breviceps* have been examined using electrophoresis. Of the 21 loci examined, eight were polymorphic, and the average heterozygosity was 3.9%. One allele (leucine amino peptidase-1^a) was unique to the genome, and a mean intraracial identity value of 0.953 was calculated for this chromosomal race (Bohlin and Zimmerman, 1982). Using protein electrophoresis, Zimmerman and Gayden (1981) found a genetic identity of 0.696 between *G. bursarius* and *G. breviceps* in central Texas. Bohlin and Zimmerman (1982) also compared 37 populations from Texas, Oklahoma, and Louisiana, and reported a genetic identity of 0.685 between the above species. The genetic identity between *G. breviceps* and race F of *G. attwateri* was 0.705, and was 0.709 between *G. breviceps* and race G of *G. attwateri*. Mean heterozygosity for *G. breviceps* was 1.5% and five fixed-alternate alleles were found between *G. breviceps* and *G. attwateri* (Dowler, 1982).

Bohlin and Zimmerman (1982) examined genic variation and chromosomal differences in a contact zone between *G. bursarius*, corresponding to race D described by Honeycutt and Schmidly (1979), and race E of *G. breviceps* near Norman, Cleveland County, Oklahoma. Populations were largely parapatric and separated by indurate soils. Mean genic identity between the two races was estimated as 0.658 (genetic distance, 0.378), similar to other taxonomic groups where reproductive isolation is essentially complete. Correspondingly, Cothran and Zimmerman (1985) reported a mean genic identity between *G. breviceps* and *G. bursarius* as 0.805 (genetic distance, 0.217) along this same contact zone. Of 78 specimens examined from the contact zone, Bohlin and Zimmerman (1982) reported one apparent F1 hybrid that was heterozygous at the leucine aminopeptidase-1, alcohol dehydrogenase-1, malate dehydrogenase-2, and 6-phosphogluconate dehydrogenase-1 loci. Based on karyotypes, one apparent F1 hybrid from the same contact zone was reported by Hart (1978), which led him also to conclude that some gene exchange was occurring between races. In a subsequent study, several animals were determined to be either F2 or backcross hybrids. Levels of heterozygosity (4.1%) within the contact zone were not high and suggested limited gene exchange (Cothran and Zimmerman, 1985).

REMARKS. *Geomys breviceps* also is called the Louisiana pocket gopher. *Geomys* is from the Greek roots *Geo* meaning earth, and *mys* meaning mouse. The specific name, *breviceps*, is from Latin roots *brevis* meaning short, and *ceps* meaning head (Schmidly, 1983). Using cranial, chromosomal, and parasite evidence, Heaney and Timm (1983) hypothesized that *G. personatus* and *G. breviceps* arose as sister species to the *G. lutescens–G. bursarius* clade. *G. lutescens* is intermediate between *G. breviceps* and *G. bursarius*. *G. pinetis* is an early offshoot less closely related to *G. breviceps* and *G. bursarius* than they are to each other. Similarly, Block and Zimmerman (1991) used allozymes to determine that *G. attwateri* and *G. breviceps* were sister taxa in a clade with *G. personatus*, but in a separate clade from *G. bursarius*. Alternatively, a phylogeny based on ribosomal DNA revealed three clades, *G. breviceps*, a *G. bursarius* group, and a *G. attwateri* group, all sharing a common ancestor (Davis, 1986).

We thank personnel at the Texas Cooperative Wildlife Collection, Texas A&M University, for loan of the skull used in Fig. 2.

LITERATURE CITED

BAIRD, S. F. 1855. Characteristics of some new species of North American Mammalia. Proceedings of the Academy of Natural Sciences of Philadelphia, 7:333–337.

BAKER, R. H., AND B. P. GLASS. 1951. The taxonomic status of the pocket gophers, *Geomys bursarius* and *Geomys breviceps*. Proceedings of the Biological Society of Washington, 64:55–58.

BLOCK, S. B., AND E. G. ZIMMERMAN. 1991. Allozymic variation and systematics of plains pocket gophers (*Geomys*) of south-central Texas. The Southwestern Naturalist 36:29–35.

BOHLIN, R. G., AND E. G. ZIMMERMAN. 1982. Genic differentiation of two chromosomal races of the *Geomys bursarius* complex. Journal of Mammalogy, 63:218–228.

BOLEY, R. B., AND T. E. KENNERLY, JR. 1969. Cellulolytic bacteria

and reingestion in the plains pocket gopher, *Geomys bursarius*. Journal of Mammalogy, 50:348–349.

BUECHNER, H. K. 1942. Interrelationships between the pocket gopher and land use. Journal of Mammalogy, 23:346–348.

BURTON, D. W., AND J. W. BICKHAM. 1989. Heterochromatin variation and DNA content conservatism in *Geomys attwateri* and *G. breviceps* (Rodentia: Geomyidae). Journal of Mammalogy, 70:580–591.

COTHRAN, E. G., AND E. G. ZIMMERMAN. 1985. Electrophoretic analysis of the contact zone between *Geomys breviceps* and *Geomys bursarius*. Journal of Mammalogy, 66:489–497.

CROSS, J. C. 1931. A comparative survey of the chromosomes of rodents. Journal of Morphology, 52:373–376.

DAVIS, S. K. 1986. Population structure and patterns of speciation in Geomys (Rodentia: Geomyidae): an analysis using mitochondrial and ribosomal DNA. Ph.D. dissert., Washington University, St. Louis, Missouri, 188 pp.

DAVIS, W. B., R. R. RAMSEY, AND J. M. ARENDALE, JR. 1938. Distribution of pocket gophers (*Geomys breviceps*) in relation to soils. Journal of Mammalogy, 19:412–418.

DOWLER, R. C. 1982. Genetic interactions among three chromosomal races of the *Geomys bursarius* complex (Rodentia: Geomyidae). Ph.D. dissert., Texas A&M University, College Station, Texas, 82 pp.

———. 1989. Cytogenetic studies of three chromosomal races of pocket gophers (*Geomys bursarius* complex) at hybrid zones. Journal of Mammalogy, 70:253–266.

ENGLISH, P. F. 1932. Some habits of the pocket gopher, *Geomys breviceps breviceps*. Journal of Mammalogy, 12:126–132.

HART, E. B. 1978. Karyology and evolution of the plains pocket gopher, *Geomys bursarius*. Occasional Papers of the Museum of Natural History, University of Kansas, 71:1–20.

HEANEY, L. R., AND R. M. TIMM. 1983. Relationships of pocket gophers of the genus *Geomys* from the central and northern Great Plains. Miscellaneous Publications, Museum of Natural History, University of Kansas, 74:1–59.

HONEYCUTT, R. L., AND D. J. SCHMIDLY. 1979. Chromosomal and morphological variation in the plains pocket gopher, Geomys bursarius, in Texas and adjacent states. Occasional Papers, The Museum, Texas Tech University, 58:1–54.

KENNERLY, T. E., JR. 1958. The baculum in the pocket gopher. Journal of Mammalogy, 39:445–446.

KIM, Y. J. 1972. Studies of biochemical genetics and karyotypes in pocket gophers (family Geomyidae). Ph.D. dissert., University of Texas, Austin, 112 pp.

MERRIAM, C. H. 1895. Monographic revision of the pocket gophers family Geomyidae (exclusive of the species of *Thomomys*). North American Fauna, 8:1–258.

QUMSIYEH, M. B., C. SANCHEZ-HERNANDEZ, S. K. DAVIS, J. C. PATTON, AND R. J. BAKER. 1988. Chromosomal evolution in *Geomys* as revealed by G- and C-band analysis. The Southwestern Naturalist, 33:1–14.

SCHMIDLY, D. J. 1983. Texas mammals east of the Balcones fault zone. Texas A&M University Press, College Station, 400 pp.

TIMM, R. M., AND R. D. PRICE. 1980. The taxonomy of *Geomydoecus* (Mallophaga: Trichodectidae) from the *Geomys bursarius* complex (Rodentia: Geomyidae). Journal of Medical Entomology, 17:126–145.

TUCKER, P. K., AND D. J. SCHMIDLY. 1981. Studies of a contact zone among three chromosomal races of *Geomys bursarius* in East Texas. Journal of Mammalogy, 62:258–272.

WILLIAMS, L. R., AND G. N. CAMERON. 1991. Geomys attwateri. Mammalian Species, 382:1–4.

WOOD, J. E. 1949. Reproductive pattern of the pocket gopher (*Geomys breviceps brazensis*). Journal of Mammalogy, 30: 36–44.

———. 1955. Notes on young pocket gophers. Journal of Mammalogy, 36:143–144.

ZIMMERMAN, E. G., AND N. A. GAYDEN. 1981. Analysis of genic heterogeneity among local populations of the pocket gopher, *Geomys bursarius*. Pp. 272–287, *in* Mammalian population genetics (M. H. Smith and J. Joule, eds.). University of Georgia Press, Athens, 380 pp.

Editors of this account were TROY L. BEST and KARL F. KOOPMAN. Managing editor was DON E. WILSON.

J. M. SULENTICH, L. R. WILLIAMS, AND G. N. CAMERON, DEPARTMENT OF BIOLOGY, UNIVERSITY OF HOUSTON, HOUSTON, TEXAS 77204.